

REMARKS/ARGUMENTS

Claims 1, 14, 15 and 17-25 remain active.

Claim 1 is amended to define that the matrix is a thin film of an aggregate of carbon black and that it is formed by CVD, see paragraphs [0009] and [0056] in the specification.

Claim 1 is also amended to remove the reference to thermal in the CVD method (see paragraphs [0018] and [0026]).

Claim 25 is a combination of amended Claim 1 with Claims 17, 18 and 19.

No new matter is added.

Applicants thank the Examiner for the courtesy of discussing this case with their undersigned representative on July 6, 2011. During this discussion, the amendments to Claim 1 were discussed to address the rejections under 35 USC 112, first and second paragraphs. Applicants understand that the changes to Claim 1 render the issues of thermal CVD and the nature of the matrix in terms of the carbon black no longer applicable.

The present invention is related to a particle-dispersed complex in which fine ruthenium particles are dispersed in a carbon matrix. The complex can serve as a very active electrochemical catalyst used as the sensor electrode of a solid electrolyte sensor or as the electrode of an electrochemical device. Specification at [0001], abstract.

The rejection of Claims 1, 14, 15 and 17-24 under 35 USC 103(a) citing Goto, Jain, and Kawano with evidence from Goto II and Smith is respectfully traversed.

The rejection concedes that unlike the claims, which required metallic ruthenium particles, Goto teach particles of iridium. See page 5 of the Action. Thus, the Examiner reaches into Jain for teachings of ruthenium to argue that the use of ruthenium would have been obvious. See, e.g., pages 6-7 of the Action. While Applicants acknowledge the disclosure of Jain that Ru and Ir are alternative materials, "functional equivalence does not

necessarily establish obviousness” (*In re Scott*, 323 F.2d 1016, 1019 (CCPA 1963)

(“Expedients which are functionally equivalent to each other are not necessarily obvious in view of one another.”).

Furthermore, Applicants have presented data, when compared to the iridium as described by Goto, establishes that the present invention is patentable in view of the combination of art.

As shown in Fig. 6 of Goto, the graph shows that iridium causes a current flow eight times more than platinum at a measurement temperature of 773 K (500°C) and 8kV/m (see Δ). In Fig. 11, Goto shows that the current flow of iridium is eight times more than platinum at a measurement temperature of 773K (500°C) and 8kV/m (see \bullet ($pO_2=0$)).

In contrast, in Fig. 6 of the present application, the current flow with ruthenium is 14 times more than platinum at a temperature of 350°C and 8kV/m. In Fig. 7 of the present application, the current flow with ruthenium is 25 times more than platinum under these same conditions and in Fig. 8 shows the current corresponding to the applied voltage can be measured even at a temperature of 190°C. See also, paragraphs [0061] and [0062] of the present application.

While Goto teaches that his sensor can be used at a temperature of 500°C, Goto does not provide any salient teachings as to the unexpected effect of being able to use the sensor at low temperature measurements, e.g., 190 to 350°C as in the present invention. The fact that the presently claimed complex, including ruthenium particles, is able to be used as a solid electrolyte sensor even at lower measurement temperatures would not have been reasonably expected based on the teachings in the cited references.

The reason why these results were unexpected is because ordinarily, an oxide of iridium (Ir) is only IrO_2 , but oxides of ruthenium (Ru) include four types of RuO , RuO_2 ,

RuO_3 , RuO_4 , and these oxides change reversibly with each other due to oxygen partial pressure and temperature.

Namely, as for ruthenium, the binding state of ruthenium and oxygen is changed comparatively easily depending on the surrounding environment.

The affinity of Ru for oxygen is a nature unique to Ru that can be rarely found in other substances.

On a surface of a catalytic electrode for an oxygen sensor, the following reaction generally occurs: surface adsorption of oxygen \rightarrow charge transfer \rightarrow desorption of an oxide ion, and the reverse reaction occurs at the other electrode. With Ru, however, the surface adsorption of oxygen and desorption of an ion are easily performed even at a low temperature due to a unique affinity of Ru for oxygen. With Ir, Ir binds with oxygen to form IrO_2 , and if an oxide desorbs from this, the energy required to pull away two oxide ions at the same time is required, which is different from Ru.

Thus, a first difference between Ir and Ru is the electronic configuration. The electronic configuration of Ir is $[\text{Xe}]4d^{10}4f^14d^7$ and that of Ru is $[\text{Kr}]5s^14d^7$. Ir lies in the next lower line of that of Ru in the periodic table and has a much larger number of electrons and a spatial extension of d-electron are uniform and broad.

A catalytic reaction or a reaction of donating and receiving electrons appears to be donating and receiving electrons to/from a specific binding or a portion in an electron state of a partner element. Ir and Ru have seven d electrons and the desirable number of electrons for donating and receiving electrons from/to a partner element, but Ru has more aggressive electrons. It cannot be assumed in advance what sort of electron state is optimum, but in the present invention, in connection with donating and receiving electrons to/from oxygen gas and oxygen ion of a solid electrolyte, Ru has aggressive electrons and is in a very good

electron state, which had not been found nor would have been expected until the present invention.

The present application realizes a low temperature operation using Ru which has unique affinity and reactivity with oxygen and enables a catalytic electrode with low temperature operation that could not be achieved by one containing Ir, nor would it have been reasonably expected based on the teachings of the cited art. See again, e.g., Fig. 9, 12, 13 and 14 of the present application.

On page 7 of the Action, the Examiner suggests that the temperature of the CVD process in paragraph 55 meets the limitation of Claim 15. However, that teaching is for Ir not Ru and there is no indication that that temperature would be extrapolated to Ru as in the present invention. Indeed, contrary to the Examiner's supposition, Kawano teaches that Ru(DPM)₃ suffers from difficulties as it has a high melting point of 200°C (see paragraph 0003 of Kawano). Indeed, Kawano's teachings in this regard would lead one away from using Ru in Kawano rather than towards as alleged in the rejection. *In re Kahn* 441 F.3d 977, 985-86 (Fed. Cir. 2006): "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant."

In view of the foregoing amendments and remarks, Applicants respectfully submit that the application is in condition for allowance. Applicants respectfully request favorable consideration and prompt allowance of the application.

Should the Examiner believe that anything further is necessary in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

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